INLET PORT PLUG FOR INFLATABLE THERMAL BLANKETS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to devices for warming a patient during a medical procedure, and more particularly, to an apparatus for restricting air flow through an inlet port in an inflatable thermal blanket used to warm a patient during a medical procedure.

2. Description of the Related Art

Hypothermia, a condition in which a person's body temperature drops below normal, presents serious potential consequences to a patient. Studies have shown that hypothermia occurs in nearly 75 percent of all patients who undergo surgical procedures. Based on recent numbers, this means that 14 million patients a year in the United States alone suffer from hypothermia during surgical procedures. Hypothermia during surgery may be caused by anesthesia, air conditioning within the operating room, infusion of cold blood, IV solutions, and/or irrigation fluids, in addition to other factors.

One well known method for reducing hypothermia during surgical procedures is to place an inflatable thermal blanket over a patient during a surgical procedure. The thermal blanket is inflated with a warmed airstream, exhausting warmed inflating air onto the patient. An inflatable thermal blanket was first disclosed in U.S. Patent number 4,572,188 assigned to Augustine Medical, Inc., the assignee of the present application. U.S. Patent number 5,405,371, also assigned to Augustine Medical, Inc., is directed to an inflatable thermal blanket that extends transversely across the arms and chest of a patient's body, and is for use during surgery at or below the patient's chest. These patents disclosed an airstream inlet: In later products, the airstream inlet port comprises a cardboard structure adhesively attached to the surface of the thermal blanket. A hole provided through the inlet port is sized to accept the end or nozzle of an inflation hose. In some thermal blankets, a

plurality of inlet ports are provided to allow an inflation hose to be attached at any one of a plurality of locations on the blanket. When an operator inserts the inflation hose into an inlet port, the port is closed about the hose. The surface material of the thermal blanket which coincides with the inlet port is either removed or perforated in order to allow a warmed airstream to pass from the hose through the port to the interior of the thermal blanket. The warmed airstream enters the thermal blanket and is forced out a plurality of small exhaust holes in the lower surface of the thermal blanket. Typically, the user perforates or removes that portion of the thermal blanket which covers an inlet port only when that port is to be used. Accordingly, each of the unused inlet ports remains sealed until after the first use.

One problem with this design is that if the operator decides in the middle of the procedure to move the inflation hose from one inlet port to another, the first port must be resealed or otherwise closed in order to prevent air from exiting through that port instead of through the holes on the lower surface of the blanket, as intended. A number of means have been used to reseal or close an inlet port after removal of an inflation hose. However, none of these means are completely satisfactory. For example, tape has been used to seal an open port, but is generally a nuisance to apply. The prior art suggests many other means and modes for sealing or closing an open port, including: adhesive strips, double sided tape, snaps, zippers, folding flaps, Ziplock®-type seal, hook and loop fastener strips, folding wire, or plastic bars. Each of these methods has a number of drawbacks. The method is either relatively costly, or it is inconvenient, requiring a great deal of attention or time of an operator, possibly during critical moments. Such methods and means require accommodation in manufacture of a thermal blanket, increasing production costs and decreasing manufacturability.

Accordingly, it would be desirable to provide a method and apparatus for closing inlet ports in an inflatable thermal blanket such that the port may be opened and closed conveniently and repeatedly.

SUMMARY OF THE INVENTION

The present invention is a method and apparatus for conveniently and removably closing open inlet ports within an inflatable thermal blanket.

In accordance with the present invention, an inlet port plug includes a generally planar sheet of material which is flexible and/or resilient. The planar sheet has a shape that, with flexure of the sheet, is partially receivable within the opening of an inlet port and, with unflexing of the sheet, is retained in the opening by one or more extensions that engage the periphery of the opening. In one preferred embodiment, a generally circular sheet of material forming a central body and having a plurality of resilient side extensions extending therefrom is used to close an inlet port within a thermal blanket. In accordance with this embodiment, the central body has a diameter which is slightly smaller than the diameter of the inlet port. Preferably, four extensions extend from the central body, each extension having a generally curved or rounded periphery. Each extension is preferably formed from the same material used to form the central body, and both the central body and the extensions are sufficiently resilient to be easily flexed and to return to an essentially planar sheet when released. In accordance with the preferred embodiment of the present invention, once such extension is inserted into the inlet port, the central body and a second, preferably opposing extension are then bent to allow the second extension to be inserted into the inlet port. The result is two opposing extensions extending beyond the diameter of the inlet port at the interior of the port, which engage an inside surface of the inlet port, and two opposing extensions extending beyond the diameter of the inlet port at the exterior of the port.

The present invention may be removed from the inlet port by placing a finger under one of the extensions at the exterior of the inlet port and causing the central body to generally bend outwardly from the port. The present invention may be inserted and removed many times without significant detrimental impact to either the port or the invention.

The details of the preferred embodiment of the present invention are set forth in the

accompanying drawings and the description below. Once the details of the invention are known, numerous additional innovations and changes will become obvious to one skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an illustration of the preferred embodiment of the present invention.

FIGURE 2 is an illustration of the preferred embodiment of the present invention immediately before insertion into an inlet port.

FIGURE 3 is an illustration of the preferred embodiment of the present invention after insertion into an inlet port.

FIGURE 4 is an illustration of an alternative embodiment of the present invention.

FIGURE 5 is an illustration of the alternative embodiment of FIGURE 4 immediately before insertion into an inlet port.

FIGURE 6 is an illustration of the alternative embodiment of FIGURE 4 after insertion into an inlet port.

FIGURE 7a is an illustration of an embodiment of the invention having a distal end of an appendage tilted up ward.

FIGURE 7b is a side view of the embodiment of FIGURE 7a.

FIGURE 8a-8e illustrates a number of alternative embodiments of the invention having varied appendages.

FIGURE 9a is an illustration of an embodiment of the invention having protuberances.

FIGURE 9b is a side view of an embodiment of the invention having retractable protuberances.

FIGURE 10 is a side view of the embodiment of FIGURE 9a.

FIGURE 11 is an illustration of the embodiment of FIGURE 9a suspended over a port.

FIGURE 12 is an illustration of the embodiment of FIGURE 9a inserted in the port.

FIGURE 13 is an illustration of an embodiment having threads.

FIGURE 14 is an illustration of the embodiment of FIGURE 13 after insertion in the port.

FIGURE 15 illustrates the present invention in use with a conventional upper body inflatable thermal blanket.

FIGURE 16 shows the present invention in use with a lower body inflatable thermal blanket.

Like reference numbers and designations in the various drawings refer to like elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout this description, the preferred embodiment and examples shown should be considered as exemplars, rather than as limitations on the present invention.

Overview

The present invention is a plug for removably closing an inlet port of an inflatable thermal blanket. One preferred embodiment of the present invention is shown in Figures 1-3. As shown Figure 1, the plug has a central body 102 that is essential circular and has a diameter equal to that of an inlet port with which the invention is to be used. Extending preferably radially outward from the central body 102 are a plurality of extensions 103. In this embodiment of the present invention, an even number of opposing extensions are provided, as shown in Figures 1-8. These extensions 103 may be substantially curved, or rounded, like the leaves of a 4-leaf clover. Alternatively, the extensions may be generally pointed, as shown in Figures 4-6. Preferably four extensions 103 are provided. However, fewer than four extensions may be provided or, as shown in Figure 4, more than four extensions 403 may be provided. The number of extensions is generally unrelated to the shape of each of the extensions. In accordance with the preferred invention, the plug is made of a generally flexible, resilient sheet of material, such as plastic or a wood pulp product, such as paper or cardboard. Preferably, the material is rigid enough to allow bending along a central axis through the center of the plug in predominantly one direction

at a time. The material is pr ferably die-cut into the desired shape. Alternatively, the material may be stamped, extruded, molded or otherwise formed into the desired shape.

In accordance with one method of the present invention, the plug is bent such that outer edges of opposing extensions may be inserted into an inlet port 201 (see Figure 2). The inlet port is typically a circular hole through a rectangular sheet 203 of cardboard. The sheet has a first (or, outer) surface 204, and a second (or, inner) surface indicated by reference numeral 206. Slits 205 about the perimeter of the port 201 allow the port to accommodate an end or nozzle of an inflation hose (not shown) which is slightly larger in outside diameter than the inner diameter of the port. As shown in Figures 3 and 6, when the plug 100 is released, the plug flattens across and substantially, if not entirely closes the port 201. The plug is retained in the port by the extensions that engage the second (or, inner) surface of the sheet 203. Preferably an equal number of extensions 103, 403 are placed inside the port 201 as remain outside the port although this is not vital to the practice of the invention.

In an alternative embodiment of the present invention shown in Figures 7a and 7b, the distal end of one or more of the extensions may be formed at an angle to allow the plug 700 to be more easily removed from the port 201. Similarly, the distal end 705 of one or more extensions 703 may be formed at a slight angle downward to allow the present invention to be more easily inserted into a port 201. It will be clear to those of ordinary skill in the art, that a number of alternative shapes may be used, as shown in Figures 8a-8e. Figure 8a shows the present invention formed as a cross. Accordingly, each of the extensions 801 are essentially rectangular. As shown in Figure 8b, the present invention has extensions 803 which are notched at the distal end 805. As shown in Figure 8b, the width of each extension 803 is less than the diameter of a central circular body 809 divided by the square root of 2. Accordingly, a portion 807 of the perimeter of the central circular body 809 forms a part of the perimeter of the plug 800. Figure 8c illustrates an embodiment of the present invention in which four generally triangular shaped extensions 811 are provided. Figure 8d illustrates an embodiment in which four relatively smaller generally triangular extensions 813 are provided. Figure 8e illustrates an embodiment of the present invention

in which extensions 815 are generally rectangular having rounded distal ends 817. It will be clear to those skilled in the art that numerous other shapes and configurations are possible. Those illustrated in Figures 1 through 8 are merely provided as exemplars.

Figure 9a illustrates yet another embodiment of the present invention. The plug 900 in Figure 9a may be vacuum-formed from a sheet of plastic. The plug 900 preferably has a flange 901 which is larger in diameter than inlet port 201 with which the plug 900 is to be used. The flange prevents the plug 900 from passing completely though the port 201. The invention has a generally vertical ring-like surface 903 that press fits into the inlet port 201. Accordingly, the diameter of the surface 903 is essentially equal of the diameter of the port 201 with which the plug 900 is to be used. The flange 901 preferably has a tab 905 which extends therefrom. The tab 905 provides the user with a handle to grasp when removing the plug 900 from a port 201.

Protruding from the wall 903 are a plurality of protuberances 907 which extend radially outward from the wall 903. Each protuberance 907 has an upper and lower slope 909, 911, respectively. The upper and lower slopes 909, 911 allow the plug 900 to be inserted and removed relatively easily, while resisting removal of the plug 900 from the port 201, such that the plug 900 is retained under normal conditions but may be easily removed when desired.

In accordance with one embodiment of the present invention, the flange 901 is sufficiently thick to allow the user to comfortably grasp the plug 900 when the plug 900 is fully inserted into an insertion port 201. For example, in one embodiment, the flange 901 is approximately 0.25 inches thick.

In one embodiment of the present invention shown in Figure 9b the protuberances 907 are retractable, and retract along the path indicated by arrow 913. When force is applied against the protuberance 907, an arm 915 flexes. A slit 917 frees the arm 915 from the wall 903 and allows the protuberance 907 to retract. Figure 11 shows the plug 900 suspended above the port 201 prior to insertion into the port. Figure 12 illustrates the plug 900 after insertion into the port 201.

Figure 13 illustrates yet another alternative embodiment to the present invention.

The plug 1300 is preferably molded from plastic. The plug 1300 is retained in the port 201 by spiral groves 13 molded/etched into the edges of the plug 1300 to form threads 1303. The plug 1300 may be screwed into the port 201, and later unscrewed from the port 201. The plug 1300 preferably has a flange 1301 which is larger than the port 201. The body 1305 of the plug 1300 preferably has a diameter which is equal to or slightly larger than the diameter of the port 201. Figure 14 is an illustration of the plug 1300 after insertion into a port 201. Only the flange 1301 is visible in Figure 14.

Figure 15 illustrates the present invention 100 in use with a conventional upper body inflatable thermal blanket 1501. Figure 16 shows the present invention 100 in use with a lower body inflatable thermal blanket 1601. The invention may generally be used with these and other inflatable thermal blankets.

Summary

A number of embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, the plugs shown in Figures 1-6 may be fabricated from any generally resilient sheet of material.

Furthermore, the nature of the material which defines the inlet port is not critical to the present invention. Accordingly, the sheet which forms the inlet port may be cardboard, plastic metal, ceramic, or any other material. Still further, the protuberances 907 shown in Figures 9a-12 may form a single continuous ring about the ring-like vertical wall 903. Still further yet, the angle of the lower and upper slope 909, 911 of the embodiment of the present invention shown in Figures 9a-12, may differ substantially from one another. Also, the plug 900 shown in Figures 9a-12 may be formed without the tab 905, and the flange may be formed at an angle other than 90° with the vertical wall 903.

Accordingly, it is to be understood that the invention is not to be limited by the specific illustrated embodiment, but only by the scope of the appended claims.